



Composition and trends of non-methane hydrocarbons over Europe observed by the CARIBIC aircraft

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The CARIBIC project (Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container) involves the monthly deployment of an instrument container equipped to make atmospheric measurements from onboard a commercial airliner, and has operated since 2005 from aboard a Lufthansa Airbus 340-600. In addition to a wide range of real-time trace gas and aerosol measurements, whole air samples are collected during each flight for subsequent laboratory analysis. Measurements made from the sampling flasks include a suite of 20 non-methane hydrocarbon (NMHCs). CARIBIC flights originate in Frankfurt, Germany with routes to Asia, South America, North America and Africa, and typical aircraft cruising altitudes of 10-12km allow for the monitoring of the upper troposphere/lower stratosphere (UT/LS) along these routes. Data collected during the aircraft's departure from, and return to, Frankfurt provide a 5 year time series of near-monthly measurements of the composition of the atmosphere above Europe.

Here we present a discussion of the composition of NMHCs in the whole air samples collected above Europe during CARIBIC flights. Over Europe more than 300 air samples were collected between May 2005 and December 2010, or about 5 samples per month. Of all of these samples collected, nearly half showed influence by stratospheric air (i.e. very low values of GHGs and NMHCs, and elevated O₃, high potential vorticity). The remaining samples were representative of the upper troposphere, and backwards trajectories for these samples indicate that a little over half were collected in air masses that had been in the boundary layer within the previous 8 days. The predominant source regions for these samples were the Gulf of Mexico and continental North America.

Owing to their wide range of chemical lifetimes and the varying composition of emissions, NMHCs transported to the upper troposphere/lower stratosphere (UT/LS) can be useful indicators of source region, photochemical processing and transport timescales of an air mass. Not only seasonal and longer-term trends in NMHCs and their composition are discussed, but also composition in air masses of different origin. Additionally, we apply relationships between the different species, particularly the NMHC, to gain a qualitative understanding of photochemical processes occurring during transport from the boundary layer to the upper troposphere over Europe.